Comparison of cloud properties retrieved from MODIS, VIRS, and surface data at the ARM SGP site

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Objectives

(1) Compare MODIS/VIRS results with surface data

(2) Compare LaRC and GSFC MODIS results with surface data

Significant contribution by Jay Mace and Yuying Zhang, University of Utah

Data Source

Time period: From Nov. 2000 to June 2001

Samples:	Daytime	Night
LaRC MODIS/Surface	69	66
LaRC VIRS	29	38
GSFC MODIS	12 stratus 9 cirrus,	No

Average: One hour for surface
30 km X 30 km for MODIS/VIRS

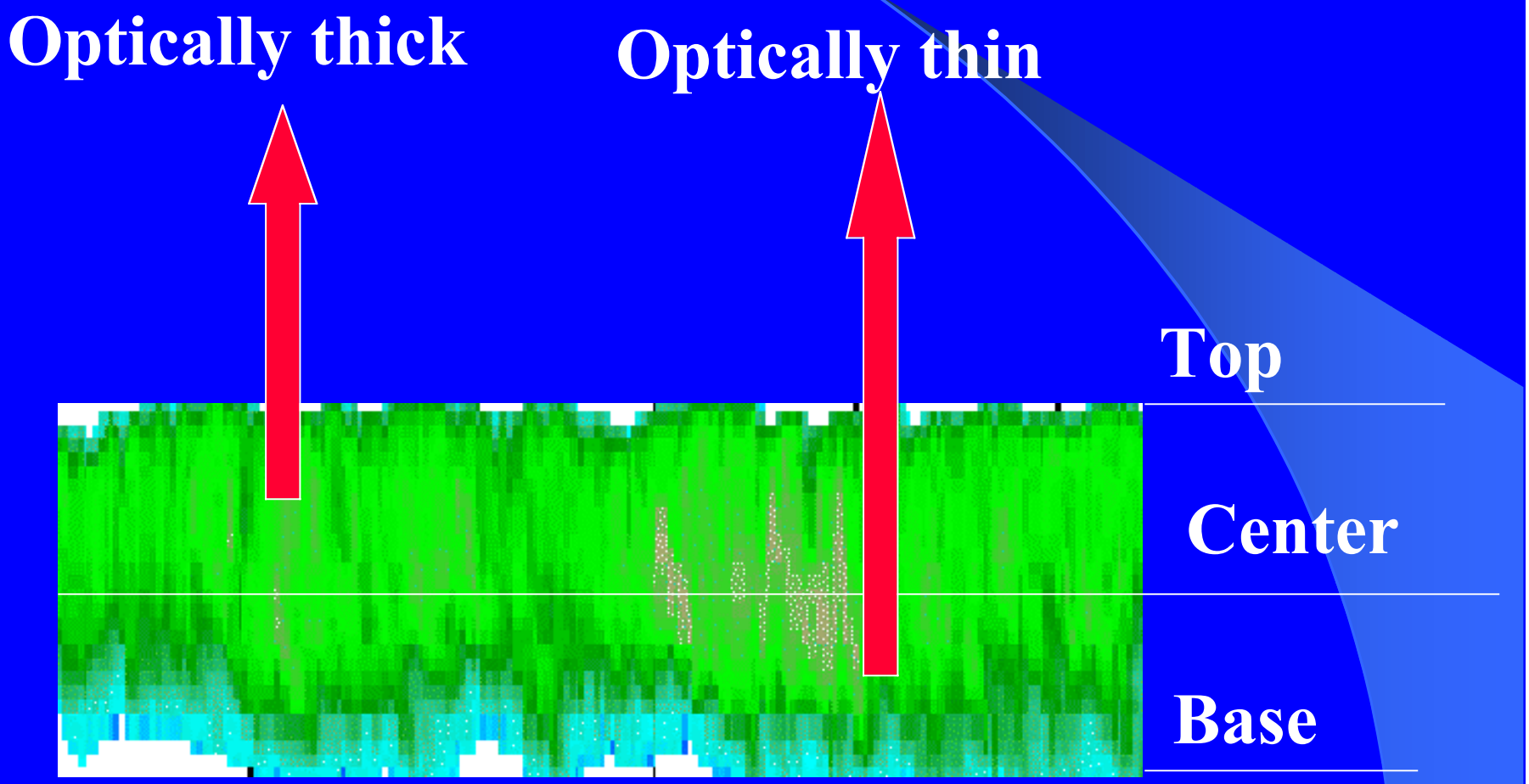
Location: DOE ARM SGP Site

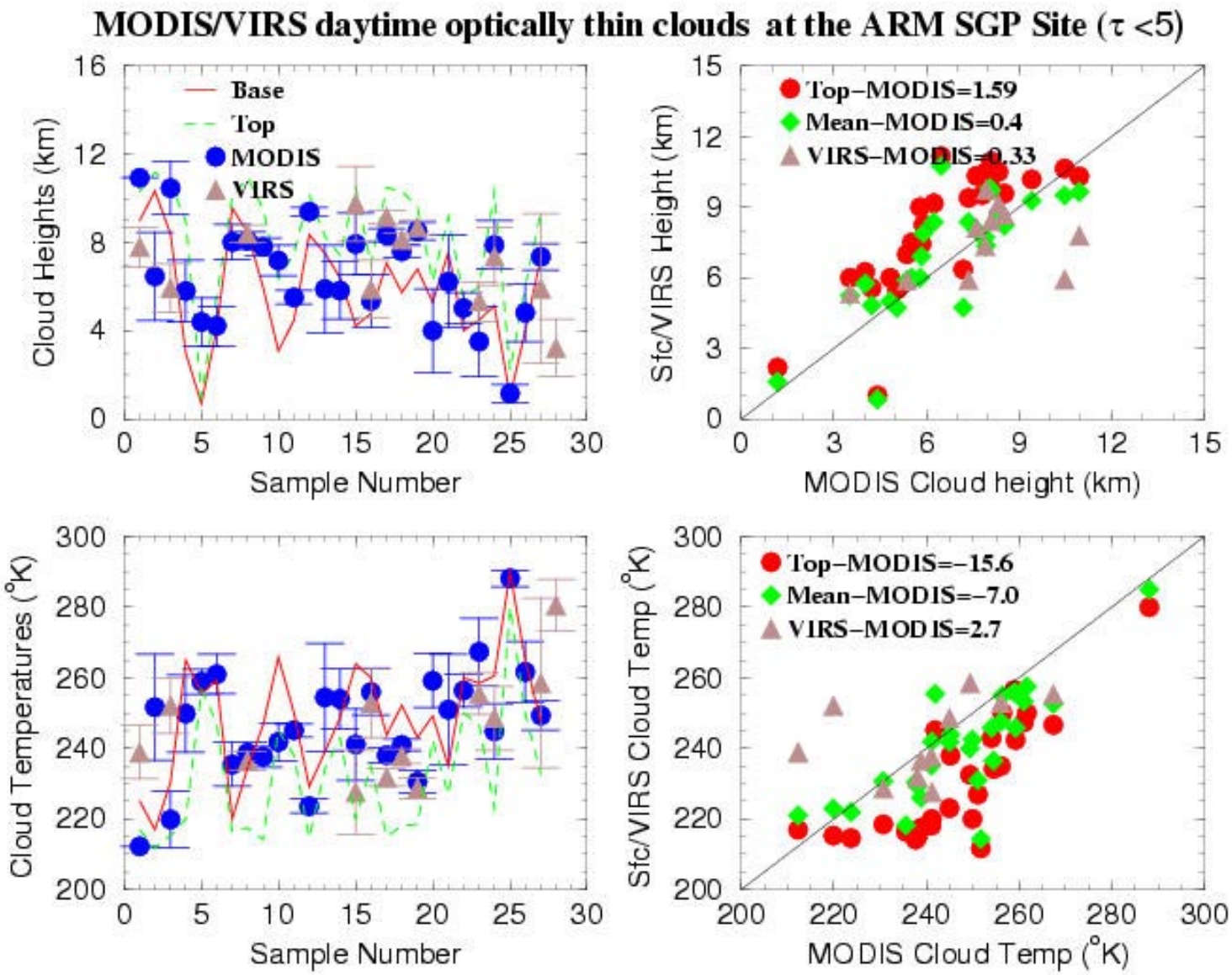
Time Difference between VIRS and MODIS/Surface

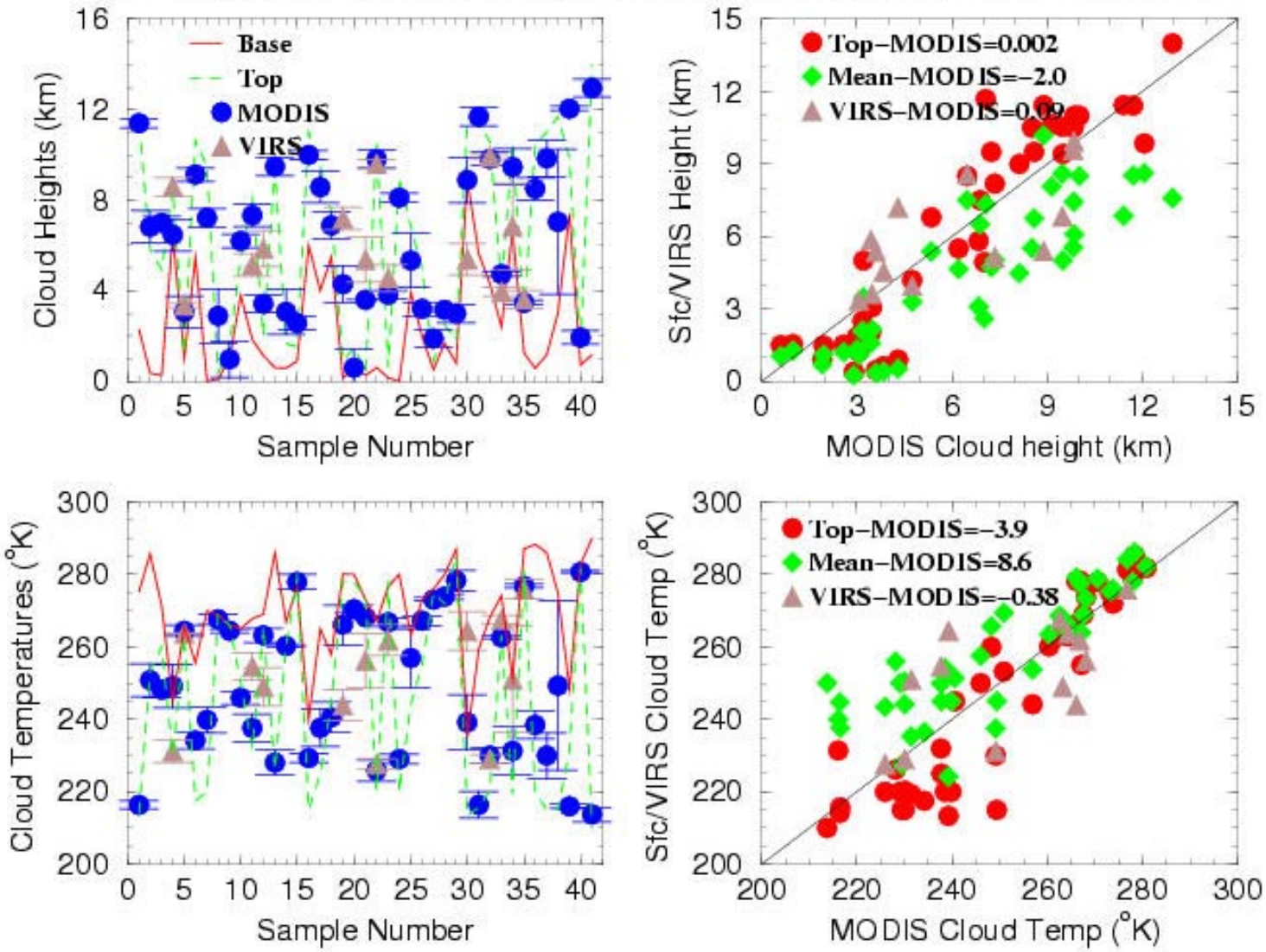
(1)Surface cloud base and top heights, and microphysics are averaged over MODIS overpass SGP Site

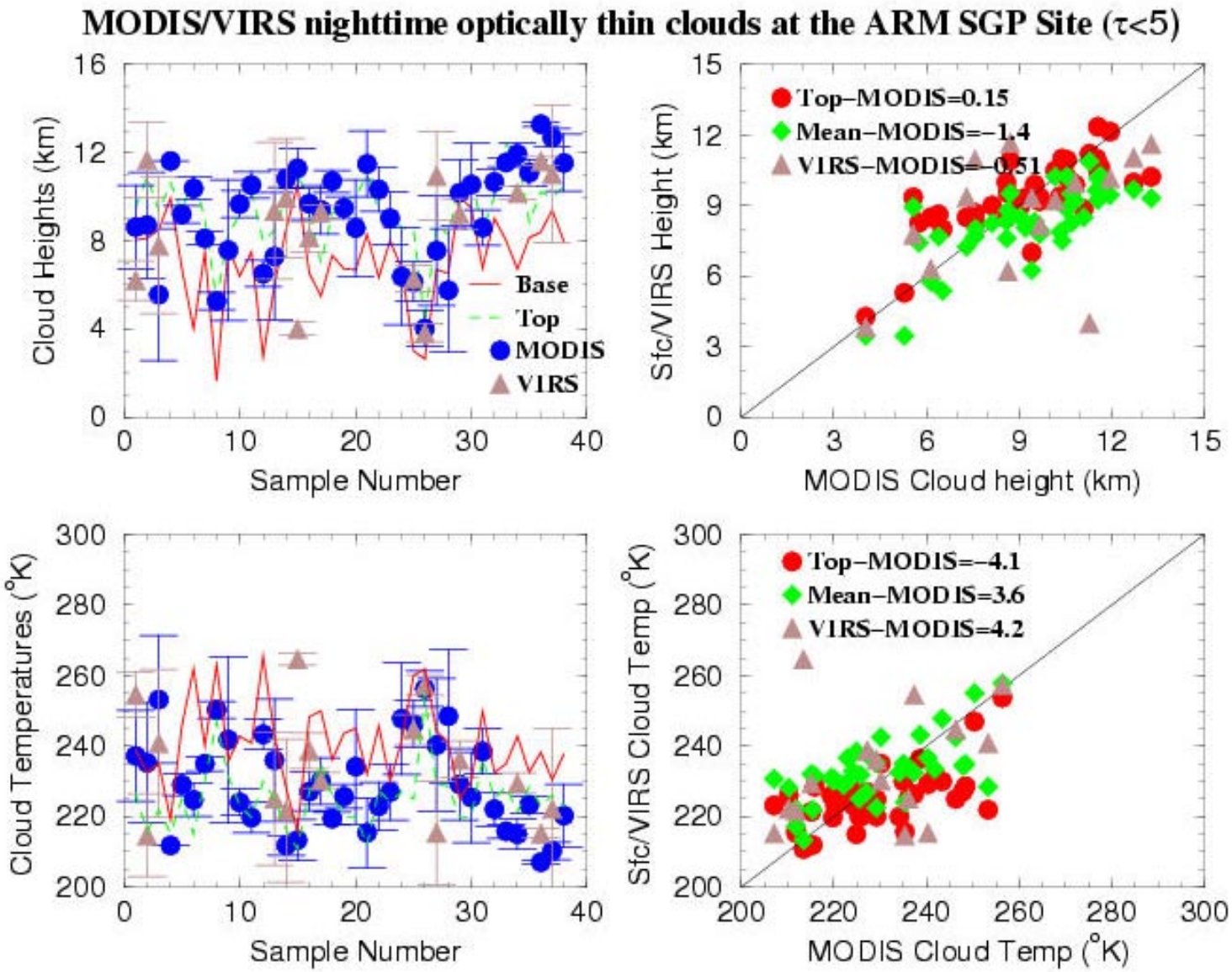
(2) VIRS results are averaged near the MODIS overpass SGP site, may have 1~5 hours difference

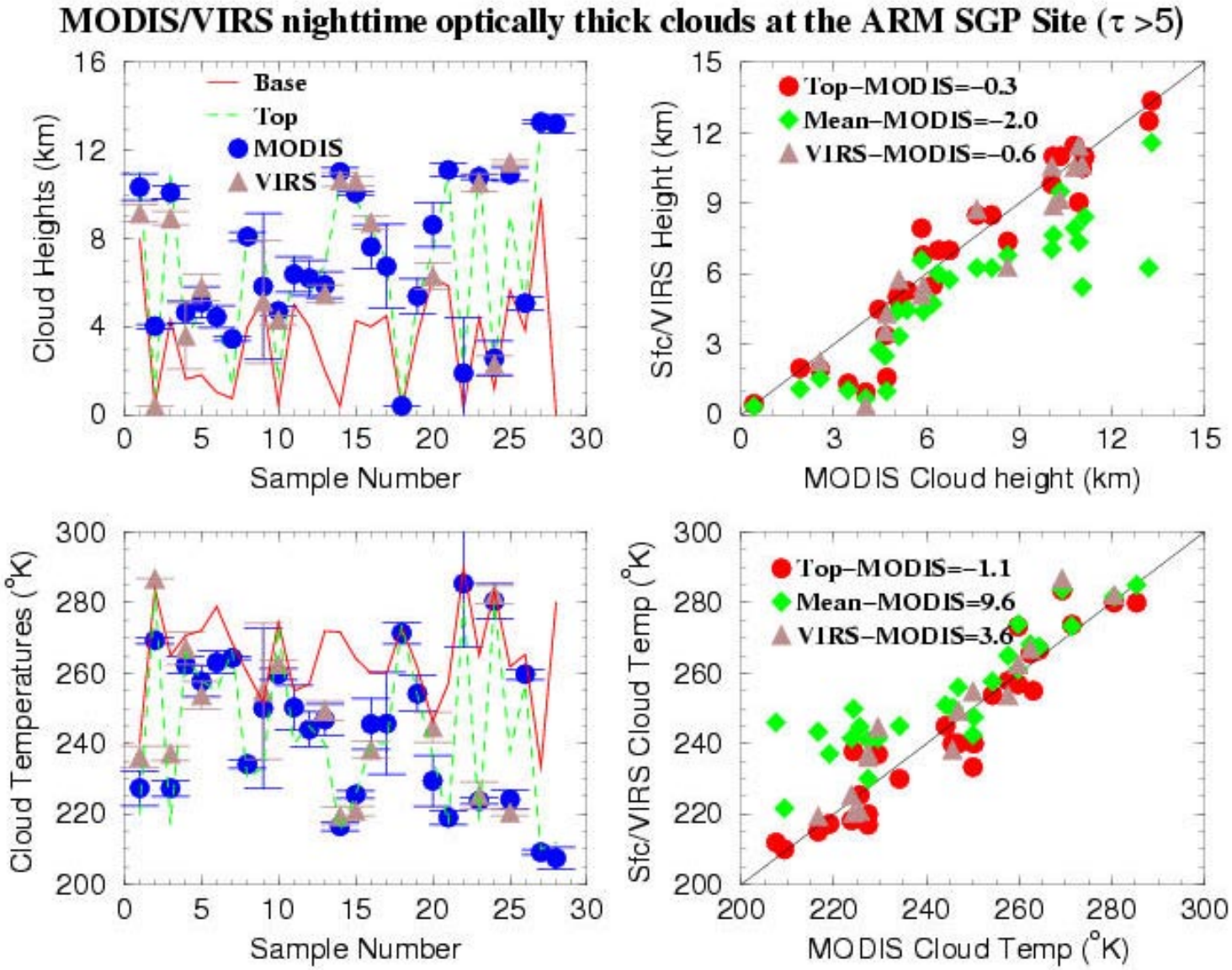
What results do we expect to get from the cloud height comparison ?

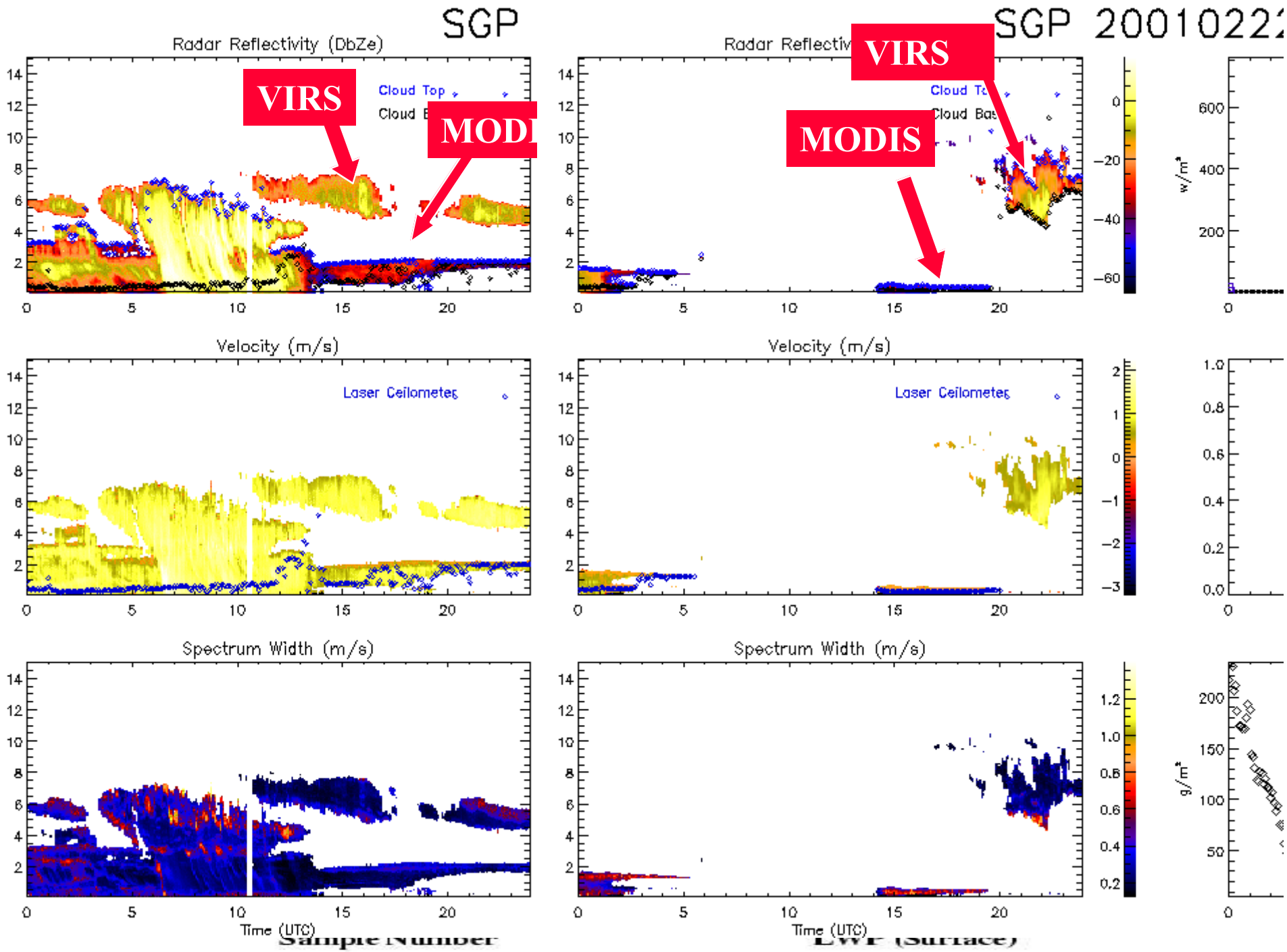


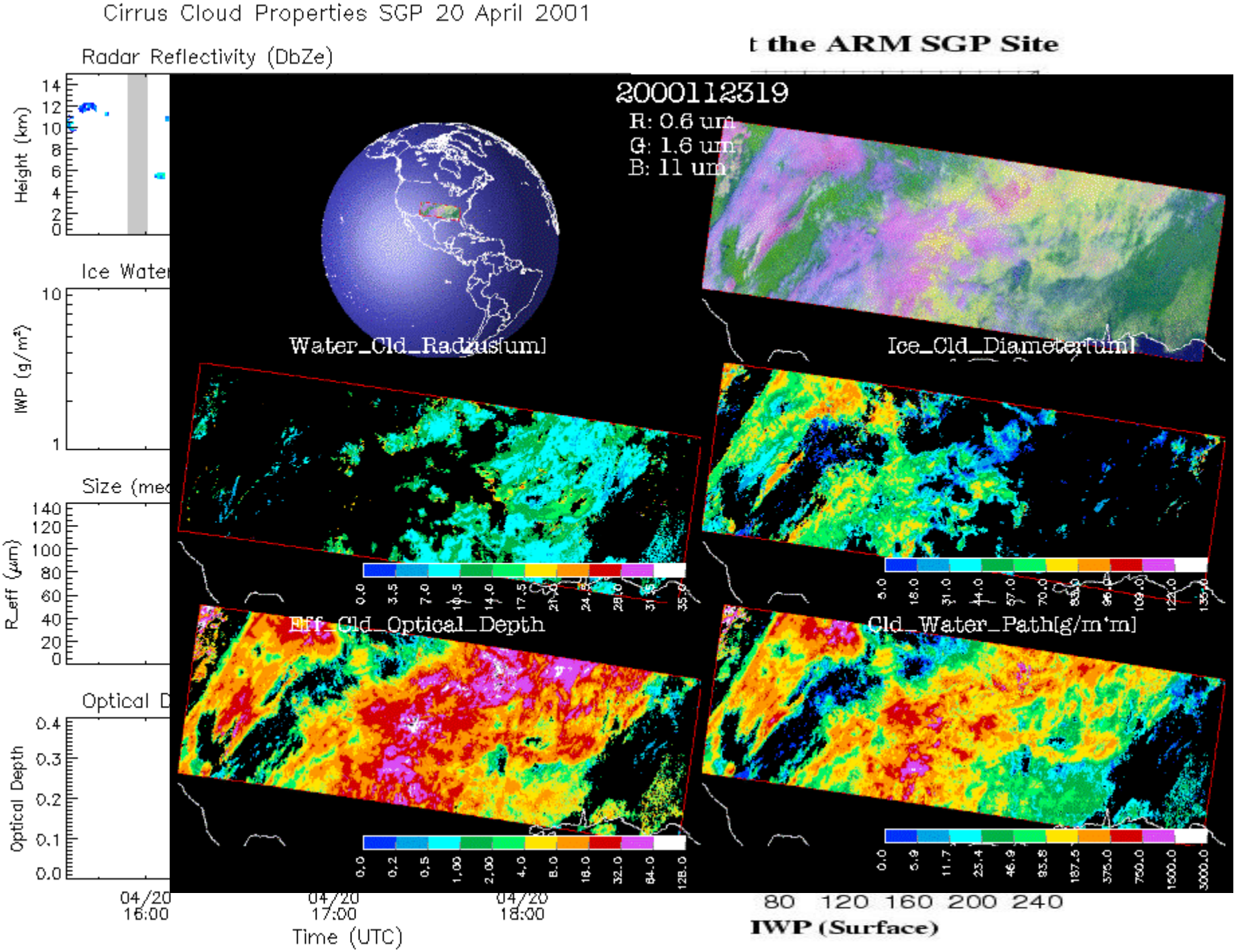

MODIS/VIRS daytime optically thin clouds at the ARM SGP Site (τ <5)
Base
Top
MODIS
VIRS
Cloud Heights (km)
Sample Number
Top–MODIS=1.59
Mean–MODIS=0.4
VIRS–MODIS=0.33
Sfc/VIRS Height (km)
MODIS Cloud height (km)
Cloud Temperatures (°K)
Sample Number
Top–MODIS=–15.6
Mean–MODIS=–7.0
VIRS–MODIS=2.7
Sfc/VIRS Cloud Temp (°K)
MODIS Cloud Temp (°K)

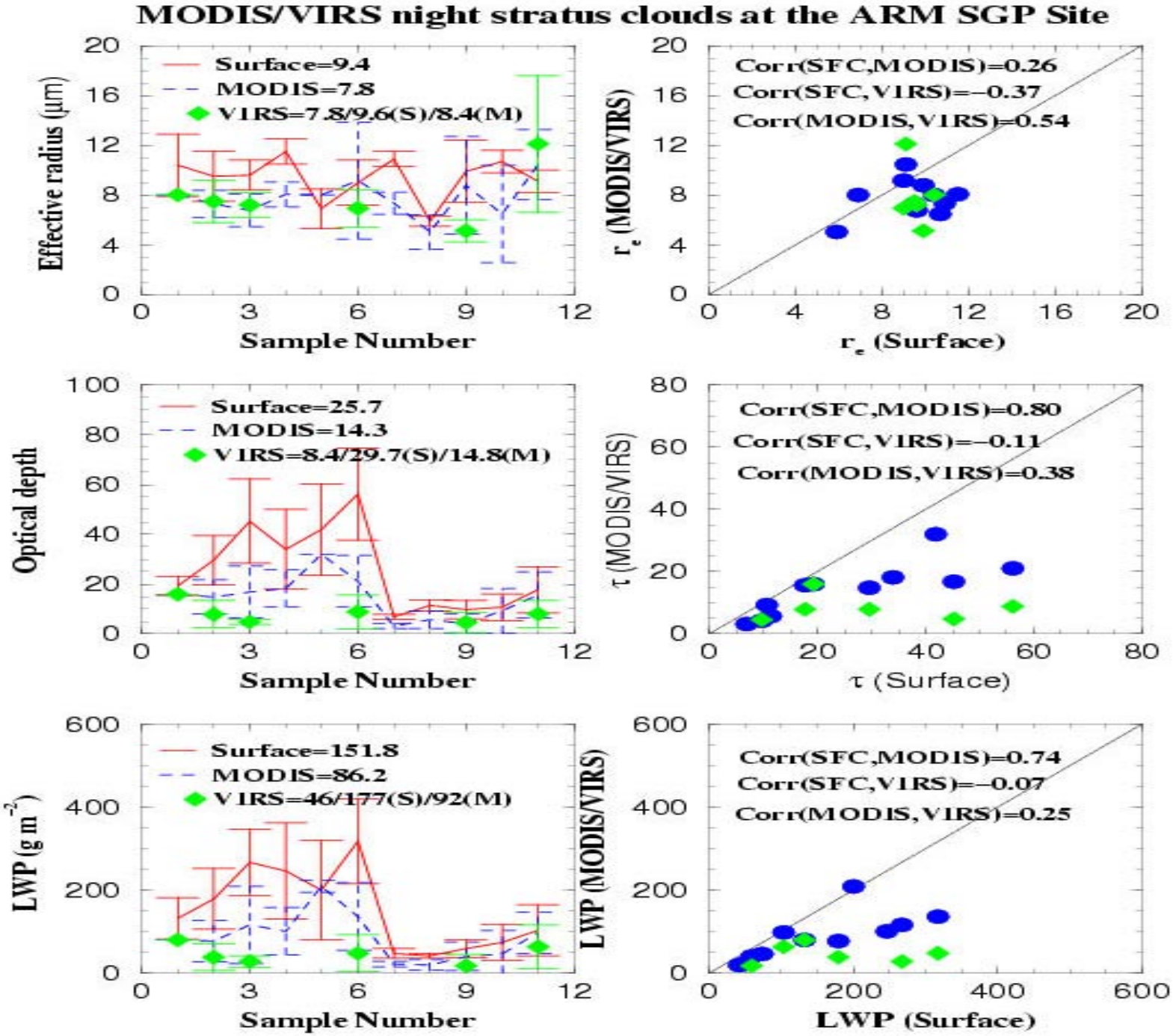

MODIS/VIRS daytime optically thick clouds at the ARM SGP Site (τ >5)
Base
Top
MODIS
VIRS
Cloud Heights (km)
Sample Number
Top–MODIS=0.002
Mean–MODIS=–2.0
VIRS–MODIS=0.09
Sfc/VIRS Height (km)
MODIS Cloud height (km)
Cloud Temperatures (°K)
Sample Number
Top–MODIS=–3.9
Mean–MODIS=8.6
VIRS–MODIS=–0.38
Sfc/VIRS Cloud Temp (°K)
MODIS Cloud Temp (°K)

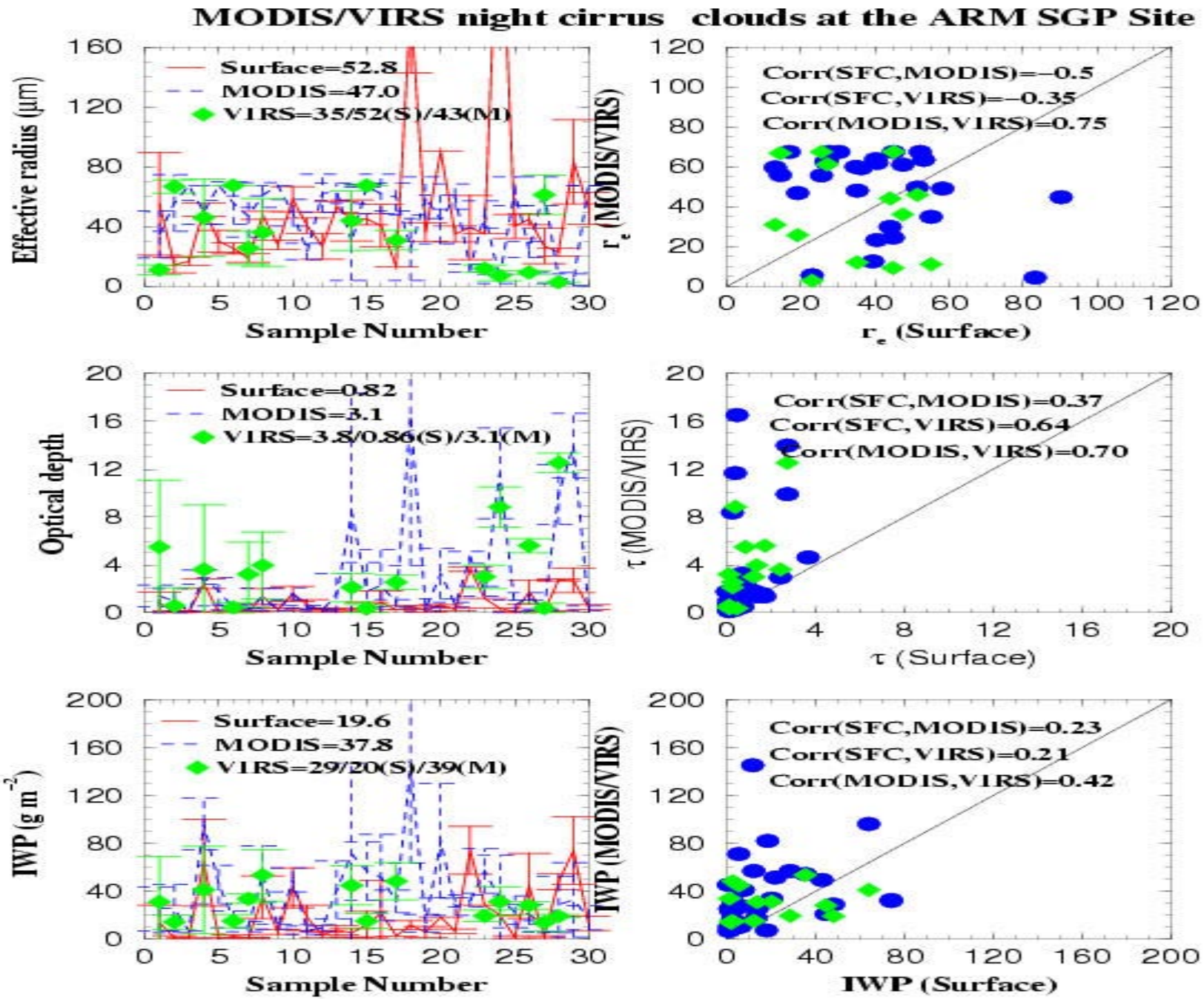

MODIS/VIRS nighttime optically thin clouds at the ARM SGP Site (τ<5)
Cloud Heights (km)
Sample Number
Base
Top
MODIS
VIRS
Sfc/VIRS Height (km)
MODIS Cloud height (km)
Top–MODIS=0.15
Mean–MODIS=–1.4
VIRS–MODIS=–0.51
Cloud Temperatures (°K)
Sample Number
Sfc/VIRS Cloud Temp (°K)
MODIS Cloud Temp (°K)
Top–MODIS=–4.1
Mean–MODIS=3.6
VIRS–MODIS=4.2

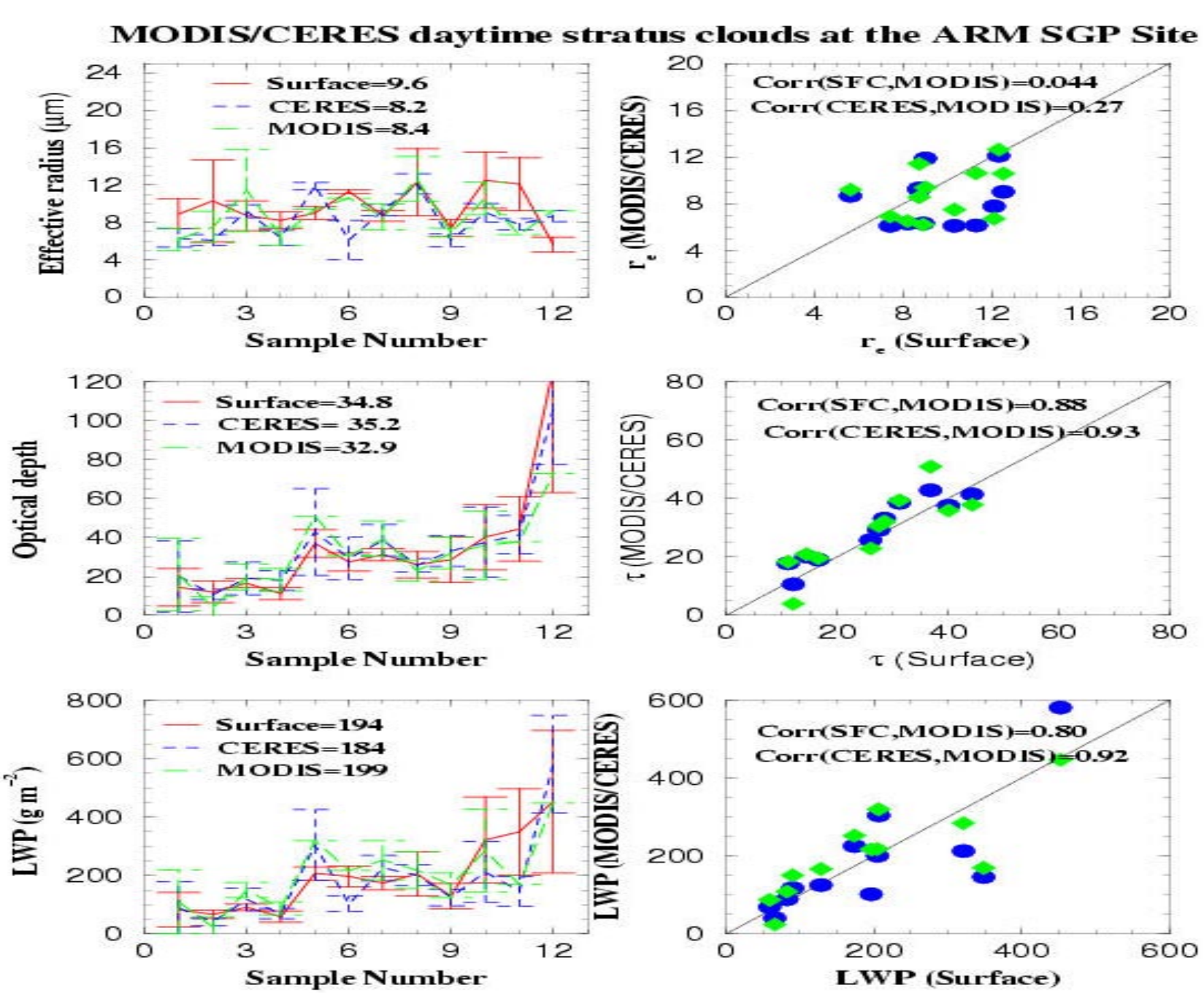

MODIS/VIRS nighttime optically thick clouds at the ARM SGP Site (τ >5)
Base
Top
MODIS
VIRS
Cloud Heights (km)
Sample Number
Top–MODIS=–0.3
Mean–MODIS=–2.0
VIRS–MODIS=–0.6
Sfc/VIRS Height (km)
MODIS Cloud height (km)
Cloud Temperatures (°K)
Sample Number
Top–MODIS=–1.1
Mean–MODIS=9.6
VIRS–MODIS=3.6
Sfc/VIRS Cloud Temp (°K)
MODIS Cloud Temp (°K)

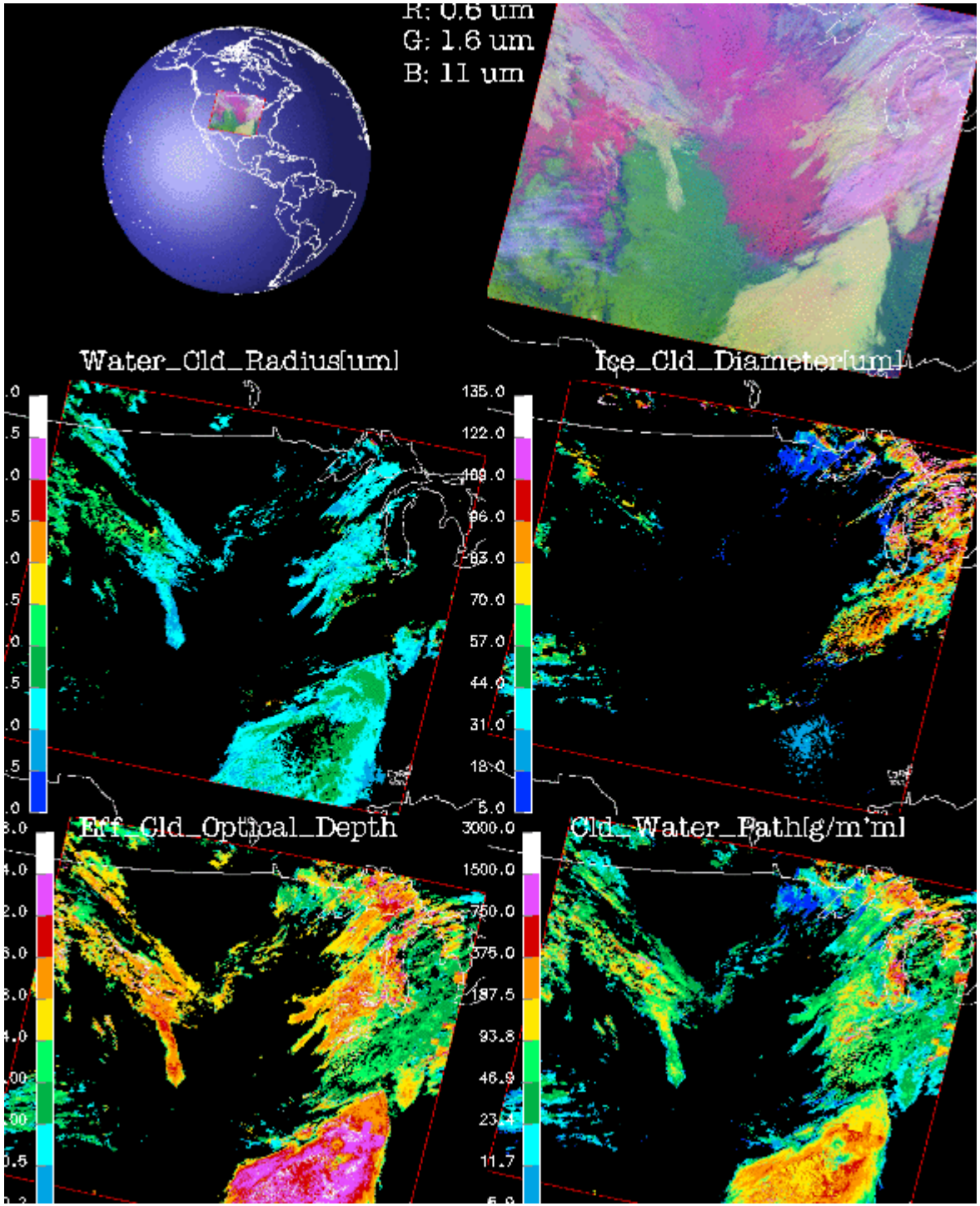

SGP
SGP 20010222
Radar Reflectivity (DbZe)
Radar Reflectiv
VIRS
MODIS
MODI
Cloud Top
Cloud Base
Velocity (m/s)
Laser Ceilometer
Spectrum Width (m/s)
Time (UTC)
w/m²
g/m²

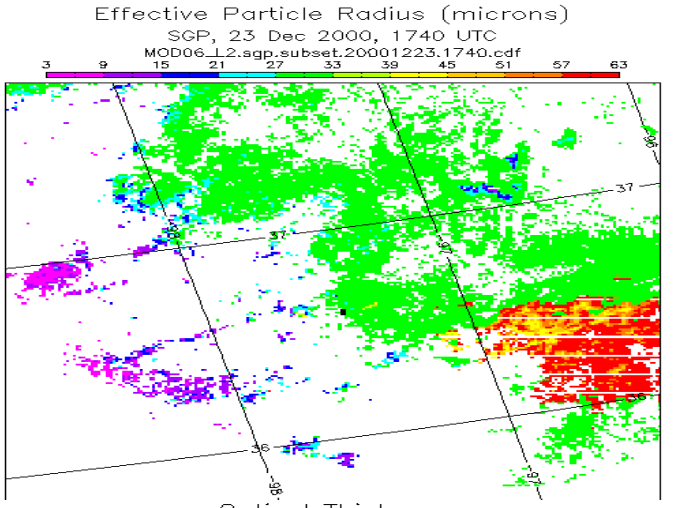

Cirrus Cloud Properties SGP 20 April 2001
t the ARM SGP Site
Radar Reflectivity (DbZe)
Height (km)
Ice Water
IWP (g/m²)
Size (mec
R_eff (μm)
Optical D
Optical Depth
04/20 16:00
04/20 17:00
04/20 18:00
Time (UTC)
2000112319
R: 0.6 um
G: 1.6 um
B: 11 um
Water_Cld_Radius[um]
Ice_Cld_Diameter[um]
Eff_Cld_Optical_Depth
Cld_Water_Path[g/m^m]
80 120 160 200 240
IWP (Surface)

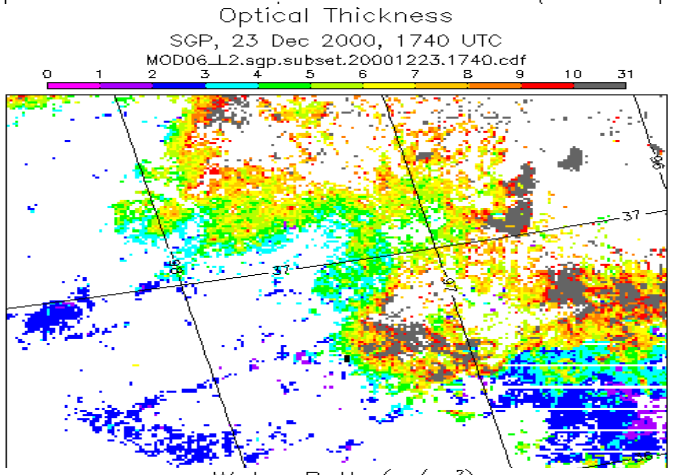

MODIS/VIRS night stratus clouds at the ARM SGP Site
Surface=9.4
MODIS=7.8
VIRS=7.8/9.6(S)/8.4(M)
Effective radius (μm)
Sample Number
Corr(SFC,MODIS)=0.26
Corr(SFC,VIRS)=−0.37
Corr(MODIS,VIRS)=0.54
r_e (MODIS/VIRS)
r_e (Surface)
Surface=25.7
MODIS=14.3
VIRS=8.4/29.7(S)/14.8(M)
Optical depth
Sample Number
Corr(SFC,MODIS)=0.80
Corr(SFC,VIRS)=−0.11
Corr(MODIS,VIRS)=0.38
τ (MODIS/VIRS)
τ (Surface)
Surface=151.8
MODIS=86.2
VIRS=46/177(S)/92(M)
LWP (g m^-2)
Sample Number
Corr(SFC,MODIS)=0.74
Corr(SFC,VIRS)=−0.07
Corr(MODIS,VIRS)=0.25
LWP (MODIS/VIRS)
LWP (Surface)

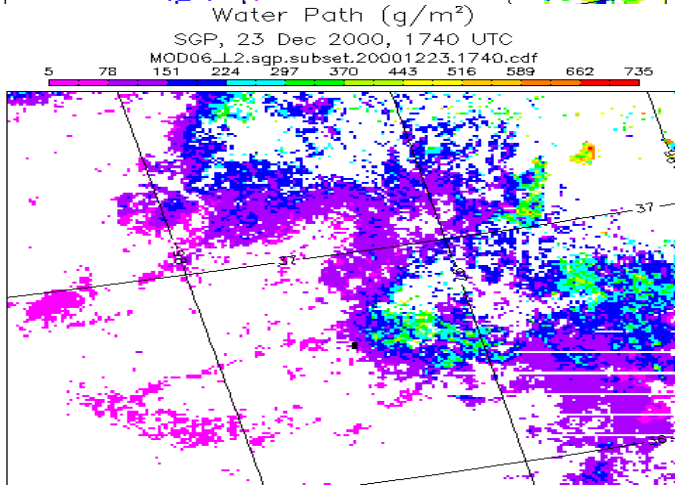

MODIS/VIRS night cirrus clouds at the ARM SGP Site
Effective radius (μm)
Surface=52.8
MODIS=47.0
VIRS=35/52(S)/43(M)
Sample Number
r_e (MODIS/VIRS)
Corr(SFC,MODIS)=−0.5
Corr(SFC,VIRS)=−0.35
Corr(MODIS,VIRS)=0.75
r_e (Surface)
Optical depth
Surface=0.82
MODIS=3.1
VIRS=3.8/0.86(S)/3.1(M)
Sample Number
τ (MODIS/VIRS)
Corr(SFC,MODIS)=0.37
Corr(SFC,VIRS)=0.64
Corr(MODIS,VIRS)=0.70
τ (Surface)
IWP (g m^-2)
Surface=19.6
MODIS=37.8
VIRS=29/20(S)/39(M)
Sample Number
IWP (MODIS/VIRS)
Corr(SFC,MODIS)=0.23
Corr(SFC,VIRS)=0.21
Corr(MODIS,VIRS)=0.42
IWP (Surface)


MODIS/CERES daytime stratus clouds at the ARM SGP Site
Effective radius (μm)
Surface=9.6
CERES=8.2
MODIS=8.4
Sample Number
Corr(SFC,MODIS)=0.044
Corr(CERES,MODIS)=0.27
r_e (MODIS/CERES)
r_e (Surface)
Optical depth
Surface=34.8
CERES= 35.2
MODIS=32.9
Sample Number
Corr(SFC,MODIS)=0.88
Corr(CERES,MODIS)=0.93
τ (MODIS/CERES)
τ (Surface)
LWP (g m^-2)
Surface=194
CERES=184
MODIS=199
Sample Number
Corr(SFC,MODIS)=0.80
Corr(CERES,MODIS)=0.92
LWP (MODIS/CERES)
LWP (Surface)


R: 0.6 um
G: 1.6 um
B: 11 um
Water_Cld_Radius[um]
Ice_Cld_Diameter[um]
135.0
122.0
109.0
96.0
83.0
70.0
57.0
44.0
31.0
18.0
5.0
Eff_Cld_Optical_Depth
Cld_Water_Path[g/m^2]
3000.0
1500.0
750.0
375.0
187.5
93.8
46.9
23.4
11.7


Effective Particle Radius (microns)
SGP, 23 Dec 2000, 1740 UTC
MOD06_L2.sgp.subset.20001223.1740.cdf
3 9 15 21 27 33 39 45 51 57 63


Optical Thickness
SGP, 23 Dec 2000, 1740 UTC
MOD06_L2.sgp.subset.20001223.1740.cdf
0 1 2 3 4 5 6 7 8 9 10 31


Water Path (g/m²)
SGP, 23 Dec 2000, 1740 UTC
MOD06_L2.sgp.subset.20001223.1740.cdf
5 78 151 224 297 370 443 516 589 662 735

Conclusions

1. LaRC MODIS Cloud effective height:
Daytime: Reasonable with surface
Nighttime: Much higher than surface

2. LaRC MODIS stratus cloud: Agree well with surface retrievals (daytime) with high correlations; smaller than surface retrievals (night) with low correlations

3. LaRC MODIS cirrus cloud: effective radius agree with surface, but optical depth and IWP are much larger than surface. High (day) and low (night) correlations.

Conclusion (cont)

4. LaRC VIRS Effective Height: Agree well with surface for day and overestimated for night, agree with MODIS for daytime lower than MODIS for night

5. LaRC VIRS stratus clouds: 50% (day) agree with or lower (night) than surface with low correlations.
   LaRC VIRS cirrus cloud: r_e smaller, τ and IWP larger than surface with high correlations

6. GSFC MODIS stratus agree well with LaRC MODIS and surface results, and more work for cirrus clouds.


Thanks for your attention!